No. N-6

FAILURE OF BRIDGE PIERS DUE TO SCOUR

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During the last few years several bridge piers have failed, owing exclusively to undermining by scour. In order to avoid accidents of this type the foundation must be carried to a depth below the lower limit of possible erosion. Yet, up to this time, no reliable rules for estimating this depth have been established. The following data indicate that some simple relation seems to exist between the distance Δh through which the level of the river rises and the distance Δt by which the scour reduces the elevation of the deepest portions of the river bed.

More than twenty years ago systematic soundings were made by the engineers of the U. S. Reclamation Service in the Colorado River not far from Yuma at different stages of the river. The river bed at this point consists to a great depth of fine, clean or silty sand and of river silt. While the water level rose through a distance $\Delta h = 12$ feet, the scour deepened the bed by $\Delta t = 40$ feet.

In the river Drau near Pettau in Austria the river bed consists of cobbles with a diameter of several inches. According to the results of soundings by F. Schaffernak a rise of the water level of $\Delta h = 3$ feet was associated with a scour of $\Delta t = 13$ feet.

In the eastern United States, a bridge pier was founded on a stratum of gravel 7 feet thick. During the construction period this surface was covered with 8 feet of mud. During an excessive highwater the pier settled 2 feet on account of scour in the gravel. From the records, it appeared probable that the entire mud deposit was completely replaced by a new layer during every highwater period. Hence the depth of foundation was inadequate from the very beginning.

In a torrential river in Colorado the base of a bridge pier was established at a depth of 10 feet below the bottom of the river channel. At that depth the river bed contained boulders with a size up to 8 cubic feet. These boulders were so tightly wedged that the difficulty of excavating the material rapidly increased with depth. The first highwater after construction caused the failure of the pier.

One of the piers of the Jetzel bridge near Hitzacker in Germany was founded at a depth of 14 feet below the surface of a flood plain, close to the bank of a shallow water course. The soil located beneath and around the pier consisted of sand. During an exceptional highwater season the pier was undermined by scour.

Reliable empirical rules for estimating the depth of scour could only be obtained from the results of numerous soundings performed during the low - and high-water season under different hydrological and geological conditions. The publication of pertinent data would be highly desirable. The records quoted lead to the tentative conclusion that the depth of scour Δt in soils with little or no cohesion is likely to assume values of the order of 3 or 4 times Δh.

No. N-7

CONCRETE FILLED STEEL CYLINDERS FOR FOUNDATIONS

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The construction of tall and heavy buildings in New York City has resulted in a further knowledge of Foundation Engineering and in the development of relatively new types of construction. One of the most important of the latter is the Concrete Filled Steel Cylinder foundation.

In order to reduce settlement to a minimum, and to guard against the building being distrubed or affected by construction operations on adjoining property, an unyielding foundation is necessary. Practically all of New York City's skyscrapers are built upon bed-rock; the few exceptions are on hard-pan immediately overlying rock.

Rock in New York City is found at varying depths below street level; the variation is considerable, and has been known to be as much as fifty feet in a hundred foot lot. The materials overlying the rock may be fill, silt, peat, sand, clay, gravel or hard-pan. Water may or may not be present in the overlying material.

These conditions, with their numerous combinations, have led to the development of various methods of foundation construction. Where rock is but a relatively short distance below the general excavation level, and ground water is absent or occurs in but small quantity, open piers to rock are invariably constructed. Where the presence of ground water and a greater depth of rock preclude the use of piers constructed in the open, piers, when used, are constructed by the pneumatic method.

For practically all cases where either open or pneumatic caissons may be used, concrete filled steel cylinders are now in general use. They are installed in less time than open piers, and are generally more economical than open piers greater than fifteen feet in depth. In comparison with pneumatic caissons, the economies in cost and time of installation are far more marked. Furthermore, for building operations in a developed section, the construction of caissons for exterior columns necessitates more underpinning of adjacent structures than that required for the installation of concrete filled steel cylinders. The vibration caused by the driving of such cylinders is less than that resulting from the driving of sheeting for an open pier. There is slight danger of loss of ground below the general excavation level, a serious condition often arising during the construction of pneumatic caissons. Steel cylinders may be driven tangent to adjoining walls, thereby providing a foundation concentric with the column load to be supported, and eliminating the costly cantilevers inherent to other types of foundations.

A group of cylinders is placed for the support of each concentration of loading. The size of a